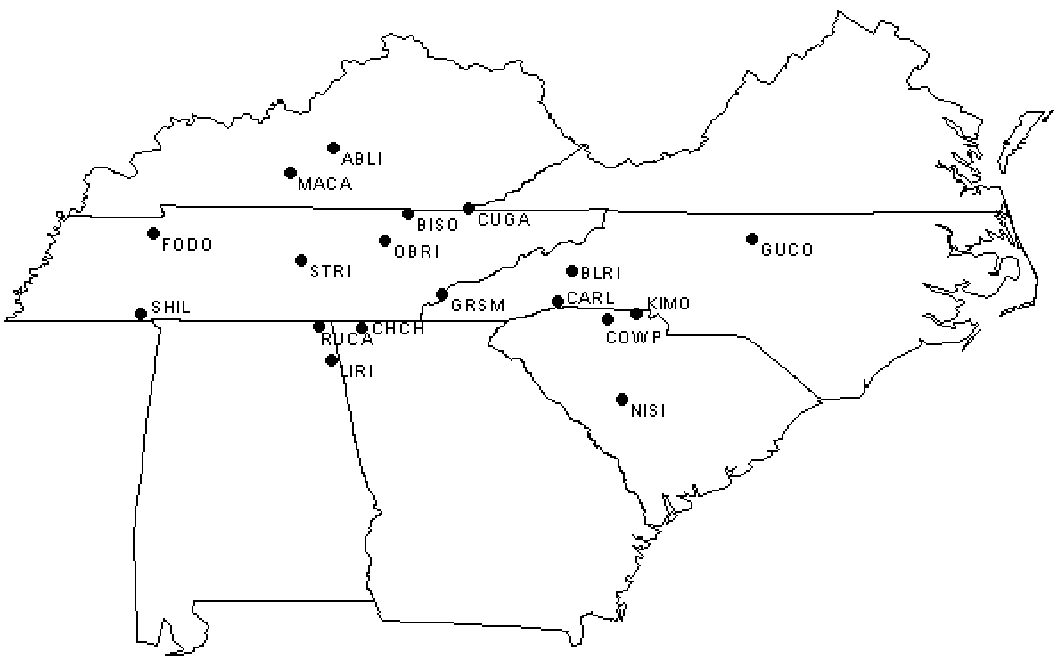
Study Plan for Vertebrate and Vascular Plant Inventories

Appalachian Highlands Network and

Cumberland/Piedmont Network,

National Park Service

Prepared by: Becky Nichols, Mike Jenkins, Janet Rock,
Keith Langdon, and Teresa Leibfreid



Appalachian Highlands Network
Big South Fork National River and Recreation Area (BISO)
Blue Ridge Parkway (BLRI)
Great Smoky Mountains National Park (GRSM)
Obed Wild and Scenic River (OBRI)

Cumberland/Piedmont Network
Abraham Lincoln Birthplace National Historic Site (ABLI)
Carl Sandburg Home National Historic Site (CARL)
Chickamauga and Chattanooga National Military Park (CHCH)
Cowpens National Battlefield (COWP)
Cumberland Gap National Historical Park (CUGA)
Fort Donelson National Battlefield (FODO)
Guilford Courthouse National Military Park (GUCO)
Kings Mountain National Military Park (KIMO)
Little River Canyon National Preserve (LIRI)
Mammoth Cave National Park (MACA)
Ninety Six National Historic Site (NISI)
Russell Cave National Monument (RUCA)
Shiloh National Military Park (SHIL)
Stones River National Battlefield (STRI)

Table of Contents

I. INTRODUCTION

This study plan is for inventories of vertebrate and vascular plant species located in parks of the Southeast Region of the National Park Service. Two networks are included in this plan: Appalachian Highlands Network and Cumberland/Piedmont Network. These combined networks encompass 18 parks which are broadly similar ecologically, have a history of working together, and are relatively close to one another, which allows for efficiencies in sampling; therefore, it is reasonable to include them both into one comprehensive plan. In this study plan, we outline the specific steps for completing inventories as described in the 1999 NPS Inventory and Monitoring publication, Guidelines for Biological Monitoring (National Park Service 1999).

The main goal of this project is to provide park managers with comprehensive, scientifically-based information about species in their parks. This type of information is lacking in most park units containing significant natural resources, and will be invaluable for making sound management decisions, as well as provide a framework for future monitoring strategies. These biological inventories will be designed to meet three basic objectives; to:

1) document at least 90% of the species estimated to occur in each park, along with their associated habitats
2) describe the distribution and relative abundance of species of special concern, and
3) provide baseline information to develop a general monitoring strategy

As discussed in this plan, these inventories will be partially conducted using a structured statistically valid study design. Although this method is less efficient at generating a species list than traditional, or non-structured, sampling, it allows for inferences about species distribution and relative abundance to be made. However, since structured designs require intensive site-specific sampling, comparatively more resources are used to gain more information about fewer species. Non-structured sampling maximizes the number of species inventoried but provides little information to managers regarding distribution, species interactions, etc. Since this study is focused on inventorying 90% of all species, the structured design, along with non-structured, will together likely meet study objectives.

Parks within the combined networks range in size from 47 ha (Abraham Lincoln Birthplace National Historic Site) to 211,097 ha (Great Smoky Mountains National Park), occur in seven states, and cover a total of 342,648 ha. Resources among the parks are extremely diverse, culturally as well as naturally. Eleven parks are cultural and include Revolutionary War sites, Civil War sites, historic home sites, and monuments. Although these sites typically are smaller than other parks in the networks and were created to protect cultural resources, they often preserve unique natural areas as well. The remaining seven parks were created for their natural and/or recreational resources.

A team assembled from GRSM (Keith Langdon, Mike Jenkins, Becky Nichols, Janet Rock) and MACA (Teresa Leibfreid) visited each of the 18 parks (excluding GRSM) from March-June, 2000. Following are brief descriptions of each park, in alphabetical order (a table of species scientific names/common names is presented in Appendix C):

<u>Abraham Lincoln Birthplace National Historic Site (ABLI) (Kentucky)</u>

Abraham Lincoln, our country's 16th president, was born in 1809 in a small cabin on Sinking Spring Farm in Kentucky. The cabin now is preserved inside a memorial building which was erected in 1909. The 47 ha site, which includes the memorial and the farm, was established as a national park in 1916 and designated as Abraham Lincoln Birthplace National Historic Site in 1959. Lincoln and his family lived in this cabin for two years when they moved a short distance away to Knob Creek, a 91 ha tract of land currently being acquired by the Park.

ABLI contains mixed deciduous woods, open fields, and a ~2 ha area of old-growth forest. The old growth is represented by large specimens of black cherry, black oak, and white ash, and the understory contains a mix of native shrubs (Carolina buckthorn) and aggressive non-natives (Oriental bittersweet). The Park's visitor center complex is landscaped with non-native plants including Amur honeysuckle and much of the woods near the birthplace monument currently are being invaded by Japanese honeysuckle.

ABLI is acquiring a 91 ha tract of land 16 km north of the current Park area, in the Knob Creek drainage. This site is in a different physiographic province from ABLI and adds considerably to the natural resources diversity. Knob Creek contains rich slopes of red buckeye and chinquapin oak, with a lush understory nearly free of non-native plant species. The Knob Creek tract also contains ridgetop woods, hay fields, a floodplain, Knob Creek, and south-facing rock outcrops.

Big South Fork National River and Recreation Area (BISO) (Kentucky, Tennessee)

Mining, agriculture, and logging practices of the early 20th century stripped much of the Cumberland Plateau of its marketable trees and accessible coal. Big South Fork National River and Recreation Area was created in 1974 as an effort to curtail the effects that these practices were having on the landscape, to provide economic recreational opportunities for the region, and to maintain the Big South Fork of the Cumberland River as a free-flowing river. The Big South Fork and its tributaries pass through 144 km of scenic gorges and valleys containing a wide range of natural and historic features.

This 50,586 ha site now is lush with second-growth forest concealing old homesteads, mining entrances, and logging roads. Much of the Park consists of a massive gorge carved into the Cumberland Plateau by the Big South Fork. Upstream topography is characterized by dendritic drainages that form narrow v-shaped gorges. Downstream, sheer bluffs dominate the gorge rim, towering over mixed-hardwood talus slopes and the river floodplain below, which is typified by river birch and American sycamore. The area above the gorge is relatively flat and is dominated by oak species, hickory species, and red maple with Virginia pine common on dry ridges and cliff edges. Mountain laurel is common in the understories of these dry forests. Mesic ravines contain large components of American beech, sugar maple, and yellow birch. Eastern hemlock and *Rhododendron* are common along narrow gorges and small streams.

Blue Ridge Parkway (BLRI) (North Carolina, Virginia)

Designed as a scenic highway, the 750 km Blue Ridge Parkway encompasses 35,894 ha and ranges in elevation from 198 m to 1,844 m as it winds along the crest of the southern Appalachian Mountains. The Parkway connects Shenandoah and Great Smoky Mountains National Parks and passes through George Washington, Jefferson, Pisgah, and Nantahala National Forests. Authorized in the 1930's and taking over 50 years to complete, the Parkway provides tremendous scenic vistas while also protecting diverse high elevation sites along a latitudinal transect.

Lower elevations along the Parkway are dominated by oak and oak-pine forests with rich cove forests common in topographically sheltered areas. As elevation increases, northern hardwood species such as American beech, yellow buckeye and yellow birch become common. At the highest elevations, spruce-fir forest dominates, although much of the Fraser fir overstory has been killed by the balsam woolly adelgid. Interspersed among the forests are small unique habitats such as grassy balds, heath balds, mountain bogs, and beech gaps.

Carl Sandburg Home National Historic Site (CARL) (North Carolina)

In 1968, Carl Sandburg Home National Historic Site became the first park to honor a poet. Carl Sandburg was a biographer, a folksinger, a lecturer, a Pulitzer Prize winning author, and was known as the Poet of the People, often writing about social justice. The Sandburgs moved to this farm, named Connemara, in 1945 and remained there for 22 years.

This 107 ha site contains relatively steep and rugged terrain, as well as low areas which were cleared for agricultural purposes. Second-growth deciduous hardwoods occupy ~80 ha of the upland areas in the Park. Specifically, this vegetational community is comprised primarily of oak, hickory, tulip poplar, maple, black gum, and white pine. Small streams originate on Big Glassy and Little Glassy Mountains and flow through the site; however, they are dammed at several locations to form small lakes and ponds. Wooded slopes contain granitic outcrops with an array of plant species specific to this unique habitat.

Chickamauga and Chattanooga National Military Park (CHCH) (Georgia, Tennessee)

During the fall of 1863, Union and Confederate armies fought for control of the city of Chattanooga which was a key rail center and gateway to the heart of the Confederacy. In September, a two-day battle was fought near Chickamauga Creek which resulted in the retreat of Union forces. This was considered the last major Confederate victory in the Western theatre but General Grant and his Union forces ultimately gained control of Chattanooga two months later. The Park consists of over 3,318 ha straddling the Georgia/Tennessee border. It was established in 1890 and is the first and largest of the national military parks. Only the three largest units of CHCH (i.e., Chickamauga Battlefield, Lookout Mountain, and the Sherman Reservation) will be covered by this inventory plan.

Chickamauga Battlefield, the largest unit of the Park, contains limestone cedar glades, creek bluffs, sagponds, beaver and quarry ponds, and open fields which are either cut twice a year for hay or mowed regularly. The oak-hickory forests surrounding the glades are comprised of post and northern red oak, loblolly pine, and pignut hickory. Lookout Mountain, a 1,120 ha section of the Park is comprised of a maintained lawn, sandstone cliffs, and rich limestone slopes. The slopes are dominated by white ash, northern red oak, and hickory species. Cave

Spring is located near the northwest boundary of this unit and the woods along Lookout Creek contain floodplain species such as hackberry. The Sherman Reservation, a 20 ha tract, is predominantly a disturbed second-growth woodland.

Cowpens National Battlefield (COWP) (South Carolina)

Early in 1781, a pivotal battle in the Revolutionary War occurred at this frontier pasturing ground. At the battle of Cowpens, the Continental Army was victorious over a larger force of British regulars, and it was a link in a chain of British defeats in the South that led ultimately to final defeat at Yorktown.

Topographically, Cowpens is relatively flat with a few small streams that form deeply cut channels. The 341 ha battlefield is a mixture of open fields and small woodlands. The open fields consist of mown fescue (an exotic grass) and dense thickets of multiflora rose (an aggressive exotic). Common trees across the Park include white oak, hickory species, southern red oak, and Virginia pine, with alder and black willow in riparian areas. A management plan currently is being developed to restore the battlefield to its historic vegetation structure and composition, which included open forests dominated by larger open-grown trees.

Cumberland Gap National Historical Park (CUGA) (Kentucky, Tennessee, Virginia)

Cumberland Gap, located where the borders of Kentucky, Tennessee, and Virginia meet, is a natural pass which has been used as a transportation corridor since prehistoric times. Migratory large game created a path through the gap long before people arrived. The Gap later became a Native American route to hunting grounds in Kentucky; however, it is best known for its importance in opening the interior of our nation to settlement by early colonists. Cumberland Gap National Historical Park was authorized by Congress in 1940 and encompasses 8,274 ha.

This diverse Park, which encompasses much of the east-west oriented Cumberland Mountain, contains 23 caves, streams, an historic settlement, beaver dams, bogs, rock outcrops, and a limestone cliff face. Much of the Park is covered by second-growth forests of mixed deciduous and oak-hickory species. Common species on mesic sites include tulip poplar, northern red oak, and American beech. On drier sites, chestnut oak, white oak, and hickories are common. An unusual bog complex on the east end of the Park is dominated by white pine and eastern hemlock.

Fort Donelson National Battlefield (FODO) (Tennessee)

During the Civil War, this Confederate fort guarded the strategic Cumberland River. Early in 1862 the Union Army, under the command of General Grant, captured Fort Donelson along with approximately 13,000 Confederate soldiers. This was the first major victory of the Civil War for the Union Army and set the stage for the Union's invasion of the deep South.

The battlefield site is 226 ha and is bordered by the impounded Cumberland River to the north, or what currently is known as Lake Barkley. FODO is a topographically diverse Park ranging from dry ridges to bottomlands, and a mosaic of forest types occur depending upon topography. In general, hills and ridges are divided by deep ravines that contain a diverse vegetation community and include tulip poplar, sugar maple, and American beech. Dry slopes are dominated mainly by oak and oak-hickory forests. The vegetation is considered transitional between mixed-deciduous forests to the drier oak-hickory forests.

Great Smoky Mountains National Park (GRSM) (North Carolina, Tennessee)

Established by Congress in 1934, Great Smoky Mountains National Park is internationally renowned as a center of biological diversity within North America. Complex ecological gradients combine to create a diverse mosaic of biotic communities in this 211,097 ha Park. The biological importance of GRSM led to its designation as an International Biosphere Reserve in 1976, and as a World Heritage Site in 1983.

Elevations in the park range from 305 m to over 2,030 m. At lower elevations, tulip poplar dominates large areas that historically were cleared and farmed. In sheltered rich coves (typically with northerly aspects), yellow buckeye, sugar maple, white basswood, and tulip poplar dominate the overstory. In coves with steeper v-shaped drainages, silver bell and hemlock dominate the canopy and *Rhododendron* often forms a thick, often impenetrable understory layer. Drier slopes (south and west facing) are dominated by chestnut oak with an understory of mountain laurel. Dry ridges typically have a large component of pine (pitch, Virginia, and Table Mountain) mixed with dry site oaks (chestnut, scarlet, and black). At higher elevations, the northern hardwood forest is prevalent, which is composed of sugar maple, yellow buckeye, yellow birch, and American beech. At the highest elevations in the Park, red spruce forests (over 1,900 m) and red spruce-Fraser fir forests (over 2,400 m) dominate. Scattered throughout the Park are small unique communities such as grassy balds, heath balds, beech gaps, and small wetlands.

Guilford Courthouse National Military Park (GUCO) (North Carolina)

In 1781, Nathanael Greene, commanding General of the Continental Army’s Southern Department, was defeated at Guilford Courthouse by the British General Lord Cornwallis. Although Greene’s army suffered defeat, his losses were slight, whereas Cornwallis suffered overwhelming losses, a situation that greatly hastened the end of the Revolutionary War. This 89 ha site preserves the battlefields and commemorates the battle with 28 monuments.

At the time of the battle, this area was predominantly under cultivation. Today, GUCO contains mowed fields and flat upland woods of mixed pine and hardwoods, particularly oak species. A small stream made up of two tributaries flows north out of the Park.

Kings Mountain National Military Park (KIMO) (South Carolina)

Kings Mountain is a rocky spur of the Blue Ridge Mountains that rises 46 m above the surrounding area. In 1780, British Major Patrick Ferguson and his loyalist militia were severely defeated by a small band of patriot forces, turning the tide on England’s attempt to conquer the South. Congress established this 1,597 ha site to become a National Military Park in 1931.

Topographically, KIMO is characterized by a series of ridges that generally run from southwest to northeast. Elevations in the Park range from 197 m to 324 m above sea level and dendritic drainages create numerous ravines. Tulip poplar, sweet gum, black walnut, and American sycamore dominate floodplain forests in the Park. On mesic and dry-mesic slopes, overstories contain white oak, red maple, and tulip poplar, and understories contain large components of flowering dogwood. Typical dry-site species include chestnut oak, scarlet oak, and shortleaf pine, with post oak and blackjack oak also common. Fire suppression and other changes in land use have drastically increased the density of trees at KIMO compared to that at the time of the battle. A management plan is underway to restore the battlefield to its historic vegetation structure.

Little River Canyon National Preserve (LIRI) (Alabama)

This 5,543 ha preserve protects the nation's longest mountaintop river, which flows for almost its entire length down the middle of Lookout Mountain in northeast Alabama. The free-flowing Little River is one of the cleanest, wildest waterways in the South and its canyons are some of the deepest (183 m) in the Southeast. This is the newest park unit in either network, being authorized in 1992.

Little River Canyon can be divided into four communities: oak-hickory forests, canyon shoulders, sandstone rock outcrops, and riparian areas. Oak-hickory forests occupy deep soils above the canyon shoulders. Downslope, shortleaf and loblolly pine are common, grading into Virginia pine on the glade-like canyon shoulders. Sandstone rock outcrops are common along the canyon shoulder and mainly harbor stunted Virginia or scrub pine. The shrub layer consists of sparkleberry, fringe tree, Georgia holly, and black gum. Riparian areas usually are narrow except in broader channels where oxbows exist, with woods of mainly red maple, beech, umbrella magnolia, sycamore, and river birch.

Mammoth Cave National Park (MACA) (Kentucky)

This is the longest recorded cave system in the world with more than 538 km explored and mapped. Geologists estimate that there could be as many as 960 km of yet undiscovered passageways. The cave ecosystem is considered one of the world's most diverse, but the Park also contains tremendous above-ground diversity. Rivers, bluffs, sinkholes, cave entrances, and ridgetops all are habitats in which are found many distinct plant and animal communities. The Green River, the main watercourse through the Park, is known as one of the most diverse rivers in North America, containing 82 fish species and providing habitat for federally endangered freshwater mussels. Mammoth Cave was authorized as a National Park in 1941, designated as a World Heritage Site in 1981, and as an International Biosphere Reserve in 1990. The Park is 21,380 ha in size.

MACA features mostly second-growth forests and small areas of old growth. American beech trees dominate mesic hollows, joined by tulip poplar and sugar maple on lower and middle slopes. White and black oaks, along with three species of hickory, occupy upland mesic sites and slopes. Old fields cover approximately 45% of the Park. These sites are largely dominated by eastern red cedar and/or Virginia pine mixed with deciduous trees along their outer margins.

Ninety Six National Historic Site (NISI) (South Carolina)

This Revolutionary War site preserves the frontier village of Ninety Six and the earthworks associated with its role as a British outpost. It was the scene of repeated confrontations between loyalists and patriots, and one of the longest sieges of the war conducted by the Continental Army. Through the mid-18th century, Ninety Six was the economic and political center of the region. It supposedly was named by traders for the distance between Charleston and the Cherokee town of Keowee.

The site is 400 ha, comprised primarily of mixed woods, riparian areas along Spring Branch, and some grassy areas, particularly around the earthworks. Bottomland forest along Ninety Six Creek contains white oak, water oak, willow oak, shagbark hickory, sweetgum, and sycamore. Oak-hickory forest dominates the upland slopes. Star Fort Lake is an 11 ha impoundment within the Site. Other water resources include 0.4 ha Little Pond and several springs in the Spring Branch area. Other communities include open grassy fields, a slash pine plantation, and abandoned early-seral fields.

Obed Wild and Scenic River (OBRI) (Tennessee)

The Obed River, Clear Creek, Daddy's Creek, and Emory River together comprise the 72 km of wild and scenic river within OBRI. These water courses have cut through the sandstone of the Cumberland Plateau to form a rugged landscape of steep gorges with cliffs rising as much as 160 m above the stream channel. This Park, which received its Wild and Scenic River designation in 1976, has an area of 2,046 ha.

OBRI and BISO share similar geological features, historic land use, and some vegetational characteristics as well. Like BISO, oak, hickory, and pine species combine with red maple to dominate overstories in the dry flat areas above cliff-lines. Mountain laurel is common in the understories of these dry forests. American beech, sugar maple, and yellow birch are typical in mesic ravines and eastern hemlock and *Rhododendron* are common in narrow gorges. River birch and American sycamore are common overstory components in the major stream bottoms.

Russell Cave National Monument (RUCA) (Alabama)

Russell Cave has one of the longest and most complete archeological records in the eastern United States. Artifacts indicate intermittent human habitation for almost 9,000 years. Varying styles of spears and arrow points show that different bands of Indians used the cave as a permanent home, as winter quarters, or, in the case of nomadic tribes, as a stopover. Russell Cave National Monument was established in 1961 when 125 ha were donated to the NPS by the National Geographic Society.

This site is 125 ha in size and contains the cave, a stream, sinkholes, and sandstone outcrops. The woods near the cave entrance are comprised of blue ash, yellow buckeye, white basswood, and tulip poplar. The stream floodplain consists of boxelder and tulip poplar. Wooded slopes contain a diverse canopy that includes black cherry, white oak, yellow buckeye, American beech, black locust, and hickory species.

Shiloh National Military Park (SHIL) (Tennessee)

The first major battle of the Civil War's Western theatre occurred at Shiloh in 1862. It was a two-day battle resulting in nearly 24,000 casualties and a decisive victory for Union forces, who later went on to seize control of the Confederate railway system in Corinth, Mississippi. The Park was established in 1894 to preserve the battle scene and is approximately 1,607 ha.

SHIL contains not only the fields where the major portion of the battle was fought, but also alluvial floodplains, mixed bottomland and swamp forests, steep river bluffs, and rock outcrops. Water resources in the Park include Bloody Pond, natural springs, the Tennessee River, and Owl Creek. Uplands are predominantly mixed oak forests and old-fields. Hardwoods dominate the river bluff slopes and ravines.

Stones River National Battlefield (STRI) (Tennessee)

One of the bloodiest battles of the Civil War occurred at Stones River during late 1862-early 1863 where 81,000 men fought for control of middle Tennessee. Although the battle was considered to be tactically indecisive, General Rosecrans claimed victory for the Union forces after General Bragg and his Confederate troops withdrew. This 287 ha site also encompasses Stones River National Cemetery which contains over 6,000 Union graves.

STRI is characterized by upland hardwood forests and successional communities dominated by eastern red cedar. Unique habitats include rock outcrops, hay fields, numerous limestone cedar glades containing endemic plant species, and a small tract of oak-hickory woods. West Fork Stones River, and its tributary Lytle Creek, have associated limestone bluffs, floodplains, and springs.

II. PROJECT DESCRIPTION

A. Sources of Existing Information

NRBib

The Natural Resources Bibliography (NRBib) contains a wide variety of literature, including published papers, proceedings from meetings, government documents, research reports, hand-written notes, species lists, information compiled by local volunteers, etc.; however, not all of this information is useful in determining the current status of inventories due to the fact that it is often unverifiable. Searches using NRBib produced a large amount of inventory information, especially considering not all sources have yet been entered. Some parks, such as MACA and BLRI, have extensive amounts of information, although it often is taxon-specific (e.g., numerous bird citations, but none for fish). Other parks, such as NISI and GUCO, don't have any lists.

In addition to searching NRBib, we gathered as much inventory information as possible during our visits to each park. Discussions with park managers and visual field inspections using available species lists helped us determine the level of completeness for each inventory. Through this process, we determined that the natural resource inventories of the 18 network parks are in various stages of completion - a few parks having all inventories completed, while others have virtually no information (Table 1). Additionally, some species lists were 20 years old or older and were considered to be out-of-date, and while most completed inventories include fully accessioned specimens, some do not, such as OBRI, which has a set of vouchers that have not been mounted or labeled and have not been placed in a herbarium.

GRSM is one park with completed systematic inventories of vascular plants and the vertebrate groups; however, the status of some of its special concern species are not well known. Here, GRSM will be included only in discussions of unique habitats and inventories of special concern species. The most current, pertinent, and verifiable literature for each taxonomic group for each park is listed in Appendix A.

Maps and GIS Layers

Digital data layers exist for most parks in these two networks (Table 2) which will be useful during the stratification phase of sample site determination. One serious limitation is that only five parks have the highest resolution 10 m x 10 m Digital Elevation Models (DEM's), as opposed to 30 m x 30 m DEM's. Also, only four parks have a completed vegetation map, and only one has a completed geology map.

B. Park-Specific Objectives

The overall objectives of the phase 1 NPS biological inventories are to document at least 90% of vertebrate and vascular plant species and to produce detailed distribution maps for species of special management concern. Each park has specific issues and objectives brought forward during a workshop at MACA in July, 1999. Park managers were asked to identify key issues, unique habitats, and special concern species. Some of the major issues to emerge (Table 3) included a lack of updated verified species checklists, a lack of information about unique habitats, and threats such as air pollution, visitor impacts, oil and gas extraction, adjacent land development, exotic species, etc. Of the 16 basic issue categories (mammals, birds, fish, reptiles/amphibians, mollusks, insects, plants, T&E species, vegetation maps, lichens, wetlands, soils, geology, exotics, caves and karst, fire management), seven were selected as high priority. They are: plants, birds, T&E species, reptiles and amphibians, mussels, vegetation maps, and exotic plants. A breakdown of park-specific objectives is presented in Table 3.

Table 1. Level of inventory completeness (by park) for the six phase 1 taxonomic groups. "Complete" indicates inventories which are at or above 90% of species documented (based on documentation and field verification).

Park	Plants	Amphibians	Reptiles	Birds	Mammals / Bats	Fish
ABLI	incomplete[a]	none	none	incomplete[b]	none / none	none

BISO	incomplete[b]	incomplete[bc]	incomplete[bc]	complete	none / incomplete[bc]	incomplete[b]
BLRI	incomplete[b]	none	none	complete	incomplete / incomplete[bc]	incomplete[b]
CARL	incomplete[a]	none	none	incomplete[b]	none / none	incomplete[b]
CHCH	incomplete[ab]	none	none	none	none / none	incomplete[b]
COWP	incomplete[a]	in progress	in progress	incomplete[b]	in progress / none	incomplete[b]
CUGA	incomplete[ab]	incomplete[bc]	incomplete[bc]	incomplete[c]	incomplete[bc] /incomplete[b]	incomplete[b]
FODO	in progress	none	none	none	none / none	none
GRSM	complete	complete	complete	complete	complete / complete	complete
GUCO	none	incomplete[bc]	none	incomplete[b]	none / none	none
KIMO	complete	in progress	in progress	none	incomplete / none	incomplete[bc]
LIRI	complete	incomplete[b]	incomplete[b]	none	none / none	complete
MACA	in progress	incomplete[bc]	incomplete[bc]	incomplete[b]	none / incomplete[c]	complete
NISI	in progress	none	none	incomplete[ab]	none / none	none
OBRI	complete	incomplete[bc]	incomplete[bc]	incomplete[b]	incomplete / incomplete	incomplete[b]
RUCA	complete	none	none	none	none / none	none
SHIL	complete	incomplete[b]	incomplete[b]	incomplete[ab]	incomplete[bc] /in progress	complete
STRI	complete	none	none	incomplete[c]	none / none	incomplete[b]

[a] visual inspection
[b] discussions with park managers
[c] checklist 20 years old or older

Table 2. Available GIS layers and maps.

Park	Landsat TM	Geology	NWI	Vegetation	Species of Concern	DRG	DOQQ	DLG HYP	DLG HYD	DLG BDY	DLG RDTR	DLG PITR	DLG RR	DEM	Other
ABLI		P	X			X	X	P	X	X	X	X	X	X-10m	1999 hydrological study
BISO	X	scan only	X		P	X	X	X	X	X	X	X	X	X-10m	Cliff line and streamhead habitat, archaeology
BLRI			X		P	X	X	P	X	X	X	X	X	X-10m	Soils in progress
CARL			P			X	X	P	X	X	X	X	X	X-30m	Viewsheds
CHCH			X	X	P	X	X		X	X	X	X	X	X-30m	Cedar glade study
COWP			P		P	X	X	X	X	X	X	X	X	X-30m	Exotics
CUGA	X	P	X		P	X	X	X	X	X	X	X	X	X-30m	
FODO			X			X	X	X	X	X	X	X	X	X-30m	
GRSM	X	P	P	P	P	X	X	P	X	X	X	X	X	X-30m P-10m	Spot99, soils in progress, fire/disturbance history
GUCO			X			X	X		X	X	X	X	X	X-30m	
KIMO			X	X	P	X	X	X	X	X	X	X	X	X-30m	
LIRI			P		P	X	X	X	X	X	X	X	X	X-30m	
MACA	X	X	X	P	P	X	X	P	X	X	X	X	X	X-30m	1998 habitat map-30m DEMs, Ikonos on order
NISI			X			X	X	X	X	X	X	X	X	X-30m	
OBRI	X		X		P	X	X	X	X	X	X	X	X	X-10m	
RUCA			P	X	P	X	X	X	X	X	X	X	X	X-30m	
SHIL			X	X	P	X	X		X	X	X	X	X	X-30m	
STRI			X		P	X	X		X	X	X	X	X	X-10m	Cedar glade study

P = Partial / In Progress
X = Complete either at park, I&M Program, or available through USGS, USFWS, etc.
BDY = Boundary
DEM = Digital Elevation Model
DLG = Digital Line Graph
DOQQ = Digital OrthoQuarterQuads
DRG = Digital Raster Graphic
HYD = Hydrology
HYP = Hypsography
Landsat TM = Thematic Mapper
NWI = National Wetland Inventory
PITR = Pipes & Transmission Lines
RDTR = Roads & Trails
RR = Railroad

Table 3. Outcome of the July, 1999 scoping workshop at MACA attended by Appalachian Cluster park representatives.

Park	Key Issues	Objectives
ABLI	• lack of baseline data • development on adjacent lands • new land acquisition	• inventory / map habitats for plants and vertebrates • determine distributions of special concern species • complete inventories at Knob Creek
BISO	• development on adjacent lands • exotics • visitor use impacts • acid mine drainage • oil and gas extraction	• map unique habitats • inventory special concern species
BLRI	• exotics • visitor use impacts • parkway maintenance and development • lack of data on rare species	• compile existing data • map habitats • complete inventories, particularly at high elevations
CARL	• lack of baseline data • exotics • ANCS+ backlog	• inventory / map habitats of vertebrates • control exotics
CHCH	• development on adjacent lands • exotics • protection of species of concern	• inventory plants and vertebrates
COWP	• lack of baseline data • exotics • air quality	• update inventories • complete all inventories
CUGA	• exotics • air quality (acid deposition) • acid mine drainage • Cumberland Gap restoration	• update inventories • complete all inventories • complete vegetation mapping • inventory bogs
FODO	• lack of baseline data	• complete inventories

	• exotics • protection of species of concern • lack of wetland / habitat data	• map habitats
GRSM	• exotics • air quality • habitat loss / fragmentation	• inventory special concern species • inventory exotics • conduct salamander research
GUCO	• lack of baseline data • development on adjacent lands	• verify checklists • complete inventories • map habitats
KIMO	• lack of baseline data • exotics	• complete inventories • map habitats (particularly wetlands) • map invasive exotics • QA/QC on plant list
LIRI	• lack of baseline data • status of species of concern	• complete vegetation mapping • inventory vertebrates • inventory special concern species
MACA	• exotics • air / water quality • status of species of concern • loss of open habitat for barren species • river impoundment from dam	• map habitats • complete vegetation mapping • map special concern species • map exotics • prescribed fire
NISI	• lack of baseline data • protection of rare species	• inventory plants and vertebrates • map special concern species
OBRI	• development on adjacent lands • water quality • threat of dam	• map unique habitats • inventory special concern species
RUCA	• lack of baseline data • status of species of concern	• inventory vertebrates • QA/QC on plant list

SHIL	• exotics • air quality • external threats from paper mill, agriculture	• inventory amphibians, reptiles, birds, insects, bats • status of species of concern
STRI	• development on adjacent lands • exotics • air / water quality	• inventory vertebrates

Special Habitats and Special Concern Species

Network park managers considered special habitats and special concern species to be key issues. "Special concern species" was selected as one of the highest ranked categories (Table 3) during the 1999 scoping workshop. Several parks (e.g., BLRI, BISO, GRSM, MACA) have some information on federally listed Threatened and Endangered (T&E) species while others have virtually none (e.g., KIMO, NISI). Parks that were at least aware of the presence of listed species often had no information on distribution within their parks.

Parks without general inventories or with incomplete inventories will be given higher funding priority than those that do. Because this is a phase 1 inventory program, aimed at discovering 90% of the species present, inventories of special concern species will be completed following the comprehensive surveys. Park managers expressed a need for maps of special habitats and the locations of special concern species. Location information will be compiled for park managers (not to be distributed) after general inventories are complete.

All parks contain special habitats that will be incorporated into the sampling design (see "General Sampling Design" section). Often these habitats contain special concern species, including federally listed species. It is important to identify these habitats during the initial inventory phase in order to not "miss" rarer species in observing the 90% rule. GIS layers describing the distribution of special habitats do not exist. Table 4 provides a summary of special habitats known to occur within each Network park.

Most park managers are aware of the presence of federally listed T&E species but usually are not familiar with the distribution of these species within their boundaries. Parks having the same listed species (e.g., Indiana bat, gray bat) would benefit from a regional expert (in this case, a small mammal specialist) so as to promote an evenness of effort and economy. Table 4 summarizes T&E species at each park.

As a federal agency, we are mandated by the Endangered Species Act and NPS Management Policies to identify and protect federal, state, and local T&E species on park lands. This also includes species which are rare or unique, declining, sensitive, or candidates for listing. Protecting these species will involve determining their distribution, critical habitat, and other life history information, such as seasonality. Active management may be required in order to maintain or increase the distribution and abundance of these species and their habitats.

Table 4. Summary of documented special habitats and federally listed species by park.

Park	Special Habitats	Threatened and Endangered Species
ABLI	• Old-growth forests • Karst (sinking springs, caves)	Unknown
BISO	• Old-growth forests • River gorge • Cliff lines • Streamheads, seeps, wet depressions • Rock outcrops	• Chaffseed (*Schwalbea americana*) (a flowering plant) • Cumberland sandwort (*Minuartia cumberlandensis*) • Cumberland rosemary (*Conradina vertillata*) • Virginia spiraea (*Spiraea virginiana*) • Cumberland elktoe (*Alasmidaonta atropurpurea*) (a mollusk) • Cumberlandian combshell (*Epioblasma brevidens*) (a mollusk) • Littlewing pearlymussel (*Pegias fabula*) (a mollusk) • Oyster mussel (*Epioblasma capsaeformis*) (a mollusk) • Tan riffleshell (*Epioblasma florentina walkeri*) (a mollusk) • Cumberland bean (*Villosa trabalis*) (a mollusk) • Duskytail darter (*Etheostoma percnurum* (a fish)

		• Red-cockaded woodpecker (*Picoides borealis*)
BLRI	• Rock outcrops/cliffs • High elevation communities • Wetlands (including bogs)	• Eastern cougar (*Felis concolor*) • Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) • Virginia big-eared bat (*Corynorhinus townsendii*) • Bog turtle (*Clemmys muhlenbergii*) • Blue Ridge goldenrod (*Solidago spithamaea*) • Braun's rock cress (*Arabis perstellata*) • Mountain bluet (*Houstonia purpurea* var. *montana*) • Spreading avens (*Geum radiatum*) (a flowering plant) • Small whorled pogonia (*Isotria medeoloides*) • Swamp-pink (*Helonias bulbata*) • Heller's blazing star (*Liatris helleri*) • Virginia spiraea (*Spiraea virginiana*) • Rock gnome lichen (*Gymnoderma lineare*)
CARL	• Granitic domes • Seeps and ponds	Unknown
CHCH	• Glades • Cliffs • Caves	• Large-flowered skullcap (*Scutellaria montana*)
COWP	• Wetlands • Springs	• Dwarf-flowered heartleaf (*Hexastylis naniflora*)
CUGA	• Mountain meadows • Bogs • Caves	• Indiana bat (*Myotis sodalis*) • Blackside dace (*Phoxinus cumberlandensis*) (a fish)
FODO	• Old-growth forest • Floodplains • Wetlands • Springs	Unknown

GRSM	• Old-growth forest • Grassy balds • Caves • High elevation communities • Geo-chemically different sites • Rock outcrops	• Spreading avens (*Geum radiatum*) (a flowering plant) • Rock gnome lichen (*Gymnoderma lineare*) • Virginia spiraea (*Spiraea virginiana*) • Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) • Indiana bat (*Myotis sodalis*) • Gray bat (*Myotis grisescens*) • Red-cockaded woodpecker (*Picoides borealis*) • Spotfin chub (*Cyprinella monacha*) (a fish) • Smoky madtom (*Noturus baileyi*) (a fish) • Yellowfin madtom (*Noturus flavipinnis*) (a fish) • Spruce-fir moss spider (*Microhexura montivaga*)
GUCO	• Moist areas	Unknown
KIMO	• Floodplains • Wetlands • Rock outcrops • Power line • Old mine shaft • Small waterfalls	Unknown
LIRI	• Canyon floor • Glades • River • Bogs	• Green pitcher plant (*Sarracenia orephila*) • Harperella (*Ptilmnium nodosum*) (a flowering plant) • Kral's water-plantain (*Saggitaria secundifolia*) (a flowering plant) • Blue shiner (*Cyprinella caerulea*) (a fish)
MACA	• Karst/cave • Glades • Bogs • River islands • Sinkholes • Hemlock hollows	• Eggert's sunflower (*Helianthus eggertii*) • Indiana bat (*Myotis sodalis*) • Gray bat (*Myotis grisescens*) • Fanshell (*Cyprogenia stegaria*) (a mollusk) • Northern riffleshell (*Epioblasma torulosa rangiana*) (a mollusk)

	• Barrens remnants • Small lake • Upland swamps • Sandstone cliff lines	• Cracking pearlymussel (*Hemistena lata*) (a mollusk) • Ring pink (*Obovaria retusa*) (a mollusk) • Clubshell (*Pleurobema clava*) (a mollusk) • Rough pigtoe (*Pleurobema plenum*) (a mollusk) • Mammoth Cave shrimp (*Palaemonias ganteri*) • Bald eagle (*Haliaeetus leucocephalus*)
NISI	• Rock outcrops • Wetlands (bogs, swamps) • Lake	Unknown
OBRI	• Old-growth forest • Cliff lines • River gorge • Seeps, wet depressions • Rock outcrops	• Cumberland rosemary (*Conradina verticillata*) • Purple bean (*Villosa perpurpurea*) (a mollusk) • Alabama lampshell (*Lampsilis virescens*) (a mollusk) • Spotfin chub (*Cyprinella monacha*) (a fish)
RUCA	• Cave	
SHIL	• Old-growth forests • Floodplains • Wetlands (swamps, springs)	• Indiana bat (*Myotis sodalis*) • Gray bat (*Myotis grisescens*)
STRI	• Cedar glades, barrens • Karst • Bluffs • River • Ponds	• Tennessee coneflower (*Echinacea tennesseensis*)

C. Overall Sampling Strategy - Terrestrial

For the purpose of this plan, terrestrial and aquatic systems each will have separate sampling designs. The 17 network parks have been divided into four sampling groups: 1) small parks (<

1,000 ha), 2) large parks (1,000-21,000 ha), 3) river canyon parks, and 4) parkways (Table 5). Within all parks, the emphasis is to sample the dominant community and land types in addition to special habitats. Once sample sites are established, a plot design will be created that allows sampling of vascular plants, mammals, birds, amphibians, and reptiles at the same sites. When possible, we have incorporated the recommendations outlined in the report "Guidance for the Design of Sampling Schemes for Inventorying and Monitoring Biological Resources in National Parks." This report was the product of a panel of sampling design experts convened in Fort Collins, Colorado in February 2000.

The sampling strategy for all parks will consist of three steps: 1) the establishment of a coarse network of grid points across the entire park, 2) the location of additional sample sites using a stratified random design (Thompson 1992), and 3) intensive searches of small areas of special habitats. The use of a coarse grid to establish sample sites ensures that they are distributed evenly across an entire area; however, one of the inherent weaknesses of a grid design is that it tends to over-sample common habitats and consistently misses rare and spatially-scattered habitats (Fortin et al. 1989, Legendre and Fortin 1989). Since rare habitats often are characterized by high biological diversity, sampling these areas is critical. In this strategy we recommend using a widely-spaced grid with the understanding that it will not provide sufficient representation of all habitats, but over-sampling of common habitats will be avoided. Once grid points are selected and overlaid onto the map of selected strata (discussion on recommended strata follows), the number of sample points by strata will be tallied. Additional sample sites will be randomly located within each under-represented strata.

<u>Sample Sites</u>

During the planning stage, it is not possible to know the exact number of sample sites we will require to achieve the goals of this inventory. The number of sample sites needed within a park will depend upon the variability of habitat, species distributions, and sampling effort. Therefore, the ultimate number of sample sites will be determined through an iterative process. Data from the first sampling year for a given taxon will be examined to determine how many additional sample sites are needed. Relationships between species accumulation and area, and species accumulation and effort will be examined to determine when sufficient sampling has occurred within a park. If data suggest that additional sampling is needed within a strata for a given taxon, additional sample sites will be randomly located and inventoried.

In the initial grid-based design, we have selected grid-point intervals that are unlikely to over-sample particular strata or divert excessive resources from the stratified samples, but provide a representative sample of common habitats in each park. Overall, the grid-point density per park is based on size. The following increments will be used: <1,000 ha; 1,000-5,000 ha; 5,000-8,000

Table 5. Initial grid sampling intensity by park group.

Park group	Area (ha)	Sample points	Grid density	Grid size (km)
Small Parks				
ABLI[1]	47	15	1 sample point/3 ha	0.18 x 0.18
GUCO	89	15	1 sample point/6 ha	0.24 x 0.24
CARL	107	15	1 sample point/7 ha	0.27 x 0.27
RUCA	125	15	1 sample point/8 ha	0.28 x 0.28
FODO	226	15	1 sample point/15 ha	0.38 x 0.38
STRI	287	15	1 sample point/19 ha	0.43 x 0.43
COWP	341	15	1 sample point/23 ha	0.48 x 0.48
NISI	400	15	1 sample point/27 ha	0.52 x 0.52
Large Parks				
KIMO	1,597	20	1 sample point/80 ha	0.90 x 0.90
SHIL	1,607	20	1 sample point/80 ha	0.90 x 0.90
CHCH				
• Chickamauga Battlefield	2,179	27	1 sample point/81 ha	0.90 x 0.90
• Lookout Mountain	1,108	14	1 sample point/79 ha	0.90 x 0.90
• Sherman Reservation	24	3	1 sample point/8 ha	0.28 x 0.28
CUGA	8,274	39	1 sample point/212 ha	1.45 x 1.45
MACA	21,380	44	1 sample point/486 ha	2.20 x 2.20
River Canyon Parks[2]				
OBRI	2,046	25	1 sample point/82 ha	0.90 x 0.90
LIRI	5,543	35	1 sample point/158 ha	1.25 x 1.25
BISO	50,586	53	1 sample point/954 ha	3.10 x 3.10
Parkways				
BLRI (road corridor)[3]	22,239	47	1 sample point/473 ha	2.18 x 2.18
• Humpback Rocks	1,214	15	1 sample point/81 ha	0.90 x 0.90
• Peaks of Otter	1,659	20	1 sample point/83 ha	0.90 x 0.90
• Devil’s Backbone	453	15	1 sample point/30 ha	0.55 x 0.55
• Smart View	282	15	1 sample point/19 ha	0.43 x 0.43
• Rock Castle Gorge	1,452	18	1 sample point/81 ha	0.90 x 0.90
• Fisher Peak	708	15	1 sample point/47 ha	0.70 x 0.70

• Cumberland Knob	324	15	1 sample point/22 ha	0.46 x 0.46
• Mahogany Rock	584	15	1 sample point/39 ha	0.62 x 0.62
• Doughton Park	2,320	29	1 sample point/80 ha	0.90 x 0.90
• E. B. Jeffress Park	418	15	1 sample point/28 ha	0.53 x 0.53
• Moses Cone Mem. Park	1,421	18	1 sample point/79 ha	0.90 x 0.90
• Julian Price Mem. Park	1,726	21	1 sample point/82 ha	0.90 x 0.90
• Linville Falls	547	15	1 sample point/36 ha	0.60 x 0.60
• Craggy Gardens	238	15	1 sample point/16 ha	0.40 x 0.40

[1] ABLI is in the process of acquiring a 91 ha tract at Knob Creek. If successful, sample size must be adjusted.

[2] River corridor included in area estimate.

[3] Sampling points located along road corridor every 10 miles (16.1 km). Units within BLRI are separated.

ha; 8,000-20,000 ha; 20,000-50,000 ha; and >50,000 ha. If grid-point sampling requires an excessive amount of resources in a given park, the grid-point interval may be increased to ensure that sufficient resources remain for stratified and specialized habitat sampling.

Small Parks

The unusual topographic, geologic, or vegetation characteristics found at these sites were recognized by historic figures such as military commanders, aboriginal leaders, and a poet. Many of these figures now are commemorated through the creation of these parks, which also preserve the unique natural areas within them. They include battlefields, archeological, and home site parks, and range in size from 47 to 400 ha. Within these small parks, we propose establishing 15 grid-point sample sites per park (Table 5). Grid densities will range from 1 sample point/3 ha at ABLI to 1 sample point/20 ha at NISI. Grid-point intervals will vary from 0.18 km (180 m) at ABLI to 0.45 km (450 m) at NISI. Since this grid interval produces a large number of sample sites relative to overall park size, we anticipate that relatively few additional sample points will be needed to sufficiently represent major strata. All parks within this group contain small areas of special habitats (Table 4) that will require intensive sampling.

Large Parks

This category includes the larger battlefields, historic parks, and natural resource parks, which are all large enough to contain a wide range of community types and topography. For parks in this group that are less than 3,000 ha (i.e., KIMO, SHIL), we will use a 0.90 km (750 m) grid-point interval (Table 5). A 1.45 km x 1.45 km grid will be used to select sample points at CUGA, and a 2.2 km x 2.2 km grid will be used at MACA. With these intervals, sample site densities range from 1 sample point/81 ha at KIMO and SHIL to 1 sample point/484 ha at MACA. Using an iterative approach, stratified sampling will ensure that delineated strata are adequately sampled. As with the smaller parks, specialized habitat will be differentiated and sampled separately. Some areas that are extremely hazardous to sample, such as cliff faces, will not be included in the grid or stratified sampling, but will be sampled as access permits. For example, due to its extremely steep slopes, the Lookout Mountain unit of CHCH will be sampled as trail access safely permits.

River Canyon Parks

This category includes parks containing riparian areas within steep canyons. Typically, the areas above the canyons are fairly level and accessible; however, steep canyon walls make accessing riparian areas difficult and present considerable hazards for sampling. For these reasons, sampling in the river canyon parks will be done in three parts. In the areas above the canyon, initially we will use a coarse grid to select sample points. Grid-point intervals will vary from 0.90 km at OBRI (1 sample point/81 ha) to 3.1 km at BISO (1 sample point/961 ha) (Table 5). Additional sample points above the canyon will be selected through stratified random sampling. In the riparian areas, we propose randomly selecting sample points equivalent to the number of points per hectare sampled above the canyon. Additional sampling points will be assigned above the canyon and in the riparian areas if species accumulation curves suggest that more sample points are needed. Due to their hazardous nature, the canyon walls will be sampled as safe access allows. As with other parks, special habitats such as rock shelters, riffles, and river islands will be sampled separately to ensure that their species diversity is captured.

Parkways

In the combined networks, there is one parkway (BLRI). BLRI offers a unique challenge since it covers a geographic gradient (North Carolina to Virginia) but often is only a few hundred meters wide. This gradient results in considerable community and species diversity. BLRI also contains 14 sub-units, such as Doughton Park and Peaks of Otter, ranging in size from 238 ha to 2,320 ha. Consequently, BLRI will require greater sampling intensity than a non-linear park of the same size. Most of the Parkway will be sampled as a transect with sampling points established on each side of the road every 10 mile (16.1 km). Road mileposts will be used to locate transect points which will result in approximately 46 sample points along the road corridor. Additional points may be added based upon stratification. Sub-units will be sampled with a grid-point interval equal to that used to sample individual parks of similar size. If needed, we will select additional sample points through stratified random sampling. In addition, special habitats such as wetlands, rock outcrops, and riparian areas will be sampled more intensely using additional plots. A random subsample of sites will be selected from any special habitat type that exists in large numbers.

Stratification

Due to their small size and less varied topography and biotic communities, we do not anticipate that small parks will require stratified sampling. If it becomes evident that additional sampling is needed in small parks, they may be stratified and sampled based upon available data layers. In large parks, stratifying the landscapes into biologically significant units will be an important step in completing this inventory. If the sole purpose of this project was to inventory vascular plants and vertebrates in each park, stratification by vegetation cover type would provide the most efficient and logical means of stratifying complex landscapes. However, since sample sites established in this study may eventually serve as locations for long-term monitoring, the use of vegetation cover types is problematic. Because vegetation constantly is changing as a result of disturbance and succession, it may not be an appropriate stratification layer for long-term monitoring programs that require strata to remain fixed. This issue is of particular importance in some historic parks (e.g., COWP, KIMO) that are developing plans to restore historic vegetation structure and species composition. Therefore, we will use topography and edaphic characteristics to stratify samples when possible (Table 6). When other data layers are unavailable or inappropriate, we will use broad vegetation classes that are more stable than narrower classification units which often encompass transitional community types. For example, SHIL generally does not have sufficient topographic relief to allow stratification based upon aspect, slope, or slope position; therefore, we will use the Park's existing vegetation map to develop strata. We recommend reducing and combining the 18 vegetation classes into 5 broad classes: 1) evergreen forest, 2) dry deciduous forest, 3) wet deciduous forest, 4) dry mixed forest, and 5) wet mixed forest.

Many stratification schemes will use DEM's to derive slope, slope position, and aspect. Currently, many parks in the combined networks only have 30 m x 30 m DEM's; however, as 10 m x 10 m DEM's become available we recommend their use. In the fairly rugged Ozark Mountains of southern Missouri, Hammer et al. (1995) found that a 30 m resolution DEM correctly classified field-measured slopes into 5% slope classes only 25% of the time. The same DEM placed field-measured slopes into correct or adjacent slope classes 69% of the time. Therefore, if 30 m x 30 m DEM's must be used, we recommend that the broadest possible slope classes be used.

Since many of the parks in the combined networks have variable topography that strongly influences species distribution, elevation, slope, slope position, and aspect will be used to stratify. Where available, soil and geologic spatial data also may be used to extract better-defined strata. For example, MACA will be stratified based upon an existing habitat map that combines slope and aspect with geologic features (Olson and Franz 1998). Elevation will be used to stratify BLRI which ranges in elevation from 198 to 1,829 m. Other parks in the combined network (e.g., KIMO, CUGA, CHCH) do not have strong enough gradients to delineate strata based purely upon elevation; therefore, GIS software will be used to combine aspect, slope, and slope position into landform units such as dry slopes, mesic slopes, floodplains, etc. Table 6 offers specific spatial data layers we recommend for stratifying each park. It is impossible to predict the number of stratified sample plots this inventory will require before sampling strata have been selected.

Table 6. Recommended sampling strata and spatial data layers available to create strata.

Park group	Recommended strata	Available data layers
Large Parks		
KIMO	Aspect, slope, slope position	30 m x 30 m DEM
SHIL	Vegetation map-broad classes	Vegetation map
CHCH		
• Chickamauga Battlefield	Aspect, slope, slope position	30 m x 30 m DEM
• Lookout Mountain	Aspect, slope, slope position	30 m x 30 m DEM
• Sherman Reservation	Aspect, slope, slope position	30 m x 30 m DEM
CUGA	Aspect, slope, slope position	30 m x 30 m DEM 10 m x 10 m DEM (partial)
MACA	Slope, aspect, geology	Habitat classification map 30 m x 30 m DEM
River Canyon Parks		
OBRI	Aspect, slope, slope position	10 m x 10 m DEM
LIRI	Aspect, slope, slope position	30 m x 30 m DEM
BISO	Aspect, slope, slope position	10 m x 10 m DEM
Parkways		
BLRI (road corridor)	Elevation	10 m x 10 m DEM
• Humpback Rocks	Aspect, slope, slope position	10 m x 10 m DEM
• Peaks of Otter	Aspect, slope, slope position	10 m x 10 m DEM
• Devil's Backbone	Aspect, slope, slope position	10 m x 10 m DEM
• Smart View	Aspect, slope, slope position	10 m x 10 m DEM
• Rock Castle Gorge	Aspect, slope, slope position	10 m x 10 m DEM
• Fisher Peak	Aspect, slope, slope position	10 m x 10 m DEM
• Cumberland Knob	Aspect, slope, slope position	10 m x 10 m DEM
• Mahogany Rock	Aspect, slope, slope position	10 m x 10 m DEM
• Doughton Park	Aspect, slope, slope position	10 m x 10 m DEM
• E. B. Jeffress Park	Aspect, slope, slope position	10 m x 10 m DEM
• Moses Cone Mem. Park	Aspect, slope, slope position	10 m x 10 m DEM
• Julian Price Mem. Park	Aspect, slope, slope position	10 m x 10 m DEM
• Linville Falls	Aspect, slope, slope position	10 m x 10 m DEM
• Craggy Gardens	Aspect, slope, slope position	10 m x 10 m DEM

General Sampling Design

In the proposed sampling design, inventories of vascular plants and vertebrates will be centered on the sample points selected with the use of: 1) grids, and 2) stratified random sampling. Once established, each of these points will be classified within The Nature Conservancy's National Vegetation Classification System (Anderson et al. 1998, Grossman et al. 1998, Weakley et al. 2000). Topographic features (aspect, slope, slope position) and recent disturbances also will be noted. This type of information is critical to mapping species distributions and determining species co-occurrences. Sampling will be conducted within a 1 ha circular plot (radius = 56.4 m) extending concentrically from each sample point (Figure 1). If the 1 ha plot extends into multiple vegetation community types, each major type will be classified within the 1 ha plot. If the 1 ha plot is divided among two or more vegetation types, all major types should be inventoried.

Whenever possible, all target species will be inventoried within the 1 ha plot [a similar 1 ha plot design has been used for the All Taxa Biodiversity Inventory (ATBI) at GRSM and has provided sufficient area for the establishment of vegetation plots, small mammal trap lines/grids, and cover board arrays]. Some types of sampling (e.g., bird point-count surveys) may require
sampling outside of the 1 h ... at, whenever possible, at least one point
be within each 1 ha plo ... ts, some inventory techniques (e.g.,
pitfall and funnel tra ... and amphibians) may be
impractical for us ... ot require sampling on all
plots to reach th ... plots is excessive,
inefficient, or i ... hers may select a subset of
plots for stand ... linked to a geographic
location, rese ... GPS unit.

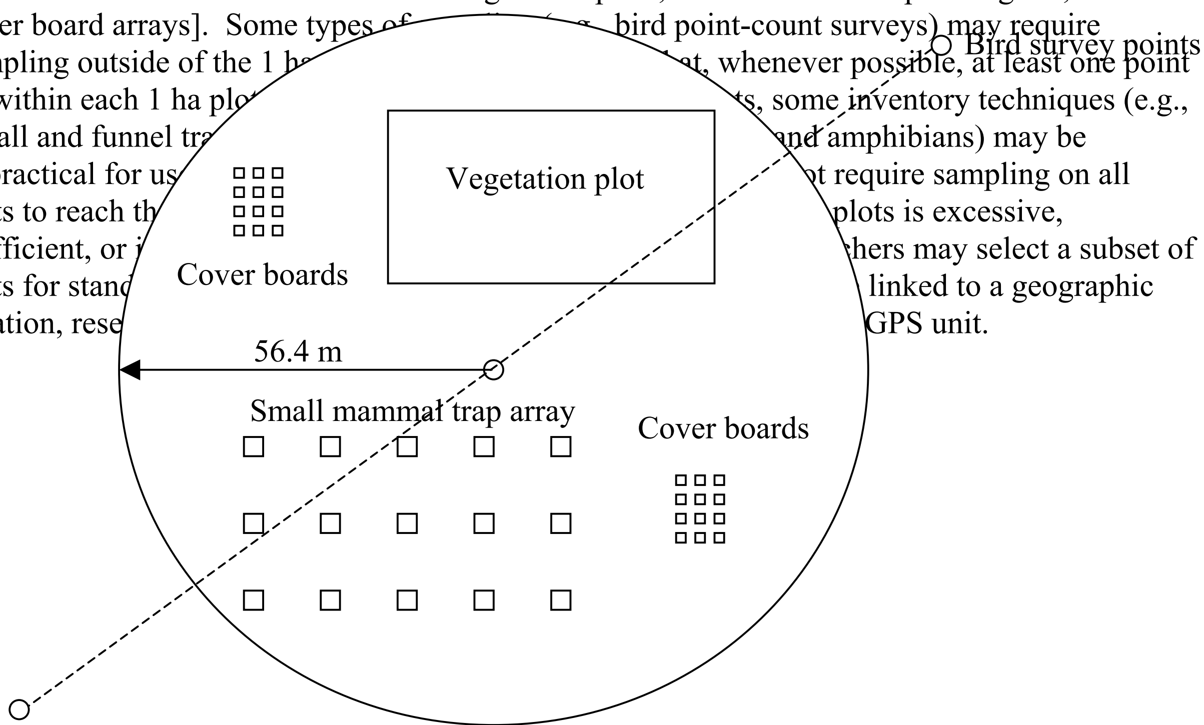


Figure 1. General plot design and potential inventory methods for vascular plants and terrestrial vertebrates.

Small, special habitats, such as seeps and outcrops, will be located from existing park records and from observations made while conducting structured (i.e., grid-point, stratified) sampling. GIS layers for these habitats do not exist. These areas are difficult to sample with a structured design; consequently, they will be sampled through intensive searches consisting of walking transects and sweeps or by installing smaller specialized plots. Species-specific searches may be appropriate in some areas, and if additional special habitat sampling is desired, usually in larger parks, a multistage design may be required (Thompson 1992).

D. Overall Sampling Strategy – Aquatic

The sampling strategy for aquatic resources will differ from the terrestrial design just described, even in a case where a stream flows through a plot established for terrestrial sampling. The primary aquatic resources in these network parks are lower order streams, and in some cases, only small portions of streams flow through the park property, in which case it is feasible that the entire length could be sampled. In cases where this is not possible, the streams will be stratified by order. Firstly, the total length of all stream segments of a particular order will be determined (e.g., 500 m of 1st order streams, 1,200 m of 2nd order streams, etc.). Sample sites then will be located at n equal intervals along the entire length of streams of each category, depending upon resources available. Special habitats have a possibility of being missed in this type of design; therefore, these areas will be sampled separately.

E. Sampling Strategy for Each Taxon

Determining the timing of projects and budget allocations for this project required having information on typical sampling methods and seasons for each taxonomic group. We held a scoping meeting on 17-18 July, 2000 at GRSM with subject matter experts (primarily USGS-BRD scientists) to ascertain this data (Table 7).

Plants

Plants in the 18 parks will be surveyed through structured sampling within the 1 ha plot established at each sample point and through intensive searches of unique habitats. Within each 1 ha plot, a 20 m x 50 m (0.1 ha) subplot will be established based upon the general design used by The Nature Conservancy in vegetation mapping and vascular plant inventory projects (TNC and ESRI 1994, Grossman et al. 1998). Within each plot, all vascular plant species will be identified and recorded according to the height strata in which they occur. Because the number of strata will vary by forest type, the researcher will identify and record the height of all vegetation strata observed on each plot. Total coverage of each species will be estimated visually (vertical projection onto the ground), and recorded within 10 cover classes [Table 8 (Peet et al. 1998)]. The same 10 cover classes also will be used to estimate the cover of each species by strata. While estimating species cover does increase the time needed to complete a plot, the added data will allow for better estimations of species distribution and diversity. The larger 1 ha plot will be searched for species not identified in the 0.1 ha subplot. Plots will be visited three times during the April to September growing season to ensure that the full suite of vascular plants are identified.

Within rare habitats (e.g., seeps, rock outcrops, small glades) that are too small and irregular for the standard plot design, the 1 ha plot will not be used. A smaller subplot will be sampled based upon 10 m x 10 m sub-sample units or modules. For example, in a small glade, a 20 m x 20 m plot (four 10 m x 10 m modules) may be used to best capture diversity. For a long, thin rock outcrop, a series of three 10 m x 10 m modules (10 m x 30 m subplot) might best be used for sampling. In some cases, even a very small plot may be impractical for sampling. In these instances, the entire habitat will be inventoried through walking sweeps and inspection of microhabitats.

Table 7. Typical sampling protocols for plants and vertebrates obtained during the network scoping meeting, July, 2000.

	Plants	Amphibians	Reptiles	Birds	Mammals	Fish
Sampling methods	• nested plots @ grids • walking transects • blocked survey	• night driving • trapping • cover boards • time / area constrained searches • drift fence arrays • litter bags • call surveys • pitfall / funnel traps • egg mass counts	• passive trapping • roadkills • cover boards • time / area constrained searches • drift fence arrays • pitfall / funnel traps • live traps	• point count survey and mapping	• trap lines • scent posts • pitfall traps • Anabat • scat / track surveys • litter raking (shrews)	• backpack electrofisher (small, large streams) • seines (small, large streams, lakes) • boat-mounted electrofisher (large streams, lakes)
Sampling season	• spring • summer • fall	• spring • summer • year-round (species	• summer	• spring (May-June) • winter	• cooler months	• late summer • early fall

		specific)		(Dec-Jan)		
Voucher types	• specimens, with duplicates in park and other repository • non-destructive samples for rare species • photos	• specimens • non-destructive tissue samples • photos	• specimens • photos	• photos • audio	• specimens / skulls • photos • tracks	• specimens

Table 8. Cover-abundance scale classes used in plot sampling of vascular plant species (after Peet et al. 1998).

Cover range	Scale value	Class midpoint
Missing but nearby	--	--
Solitary or few individuals	1	0.3
0-1%	2	0.5
1-2%	3	1.5
2-5%	4	3.5
5-10%	5	7.5
10-25%	6	17.5
25-50%	7	37.5
50-75%	8	62.5

75-95%	9	85.0
95-100%	10	97.5

Amphibians and Reptiles

For the past three years, USGS-BRD scientists have been working on a study of how to inventory the diverse amphibian fauna in GRSM. When applicable, their methodologies may be utilized in other parks for the purpose of these inventories. A variety of collecting methods will be employed to sample herpetofauna, both within and outside of the grid plots. Typically, complete species inventories of amphibians and reptiles involve searching for and collecting specimens in all possible microhabitats, both during the day and night to coincide with diurnal activity patterns. Because timing is critical to the success of an amphibian and reptile inventory, seasonal patterns of activity will be considered as well. Within the plots, the above described bird inventory design will be set up in a way so that it can be used for herpetofauna as well. Transect lines used for bird counts will be flagged and used as fixed width (5-10 m) natural cover transects.

Both amphibians and reptiles can be sampled efficiently with time and/or area constraint surveys, drift fence arrays, and cover boards. Pitfall trap arrays, used in conjunction with funnel traps, will sample snakes, lizards, and fossorial species rarely encountered visually. Road-cruising surveys will be used to sample night-active species such as snakes and toads. Additionally, roadkill specimens can provide valuable data on species composition. Specific aquatic methods will include litter bags in, or near, streams for salamanders, call surveys for frogs, egg counts for some salamanders and frogs, and live traps for some turtles.

Birds

The point count is a common method used for assessing bird species in an area. This is a count of all birds detected visually or aurally by a single observer at equidistant points in a line transect during a specified period (e.g., 10 minutes). We recommend that a line transect and three point counts be conducted at each plot, with points being a minimum of 250 m apart. Observers should do a 10 minute variable radius count on an outer point in the plot, then record all birds on a variable width transect as they walk to the center point of the plot, conduct another 10 minute variable radius count, and continue along the transect to the third point, where they conduct the third 10 minute count. Counts typically are made under acceptable weather conditions during the breeding season (May-June), although other seasons frequently are sampled as well. Bird species will be identified and recorded, along with their sex and age if desired, and their distance from the observer will be estimated as closely as possible. Distance data may then be grouped into intervals during analysis. Adding the distance factor to a simple point count allows for estimation of detection rates, an important component of an accurate survey (see Fancy and Sauer 2000). The time of first detection will be listed in two categories: within the first 3 minutes, or during the last 2 minutes (given a 5 minute count period). All of this information will be mapped on a bulls-eye data sheet, which depicts a circle around a given point and is marked with distances and directions. Each point will be geographically referenced, and will be at least 250 m apart for off-road counts, and approximately 1 km apart for roadside counts to avoid encountering the same birds.

Mammals

There is no assurance that a species count based on any particular sampling method fairly represents the true number of species in an area; therefore, a variety of techniques will be employed for determining mammal species richness. Trapping may provide a good estimate for small herbivorous or granivorous mammals, but it will provide no data or only limited data on larger mammals and on certain small mammal taxa that are difficult to capture without specialized trapping techniques.

Sherman live-traps often are used for sampling small nocturnal rodents; however, depending on the behavior of certain species, this method may not capture everything. For example, shrews rarely are captured in live-traps; therefore, other methods must be employed, such as raking litter and turning cover. For larger mammals, scat and track surveys, attractants and scent posts can be used in conjunction with infra-red triggered photography, and the resulting photograph can be used as a voucher.

For conducting bat inventories, mist nets are the most common collecting device, often placed at entrances to roosts and over water sources used by bats. Each species of bat has its own specific vocalization, and the latest technology in bat research is a device for recording these calls. Referred to as Anabat, this audio recording device, along with accompanying software, often can accurately determine bat species based on recorded calls.

Fish

When inventorying fish, it is important to recognize and thoroughly sample all habitat types. Streams in these network parks vary in size but most are lower order and will not require extensive equipment. Seines, backpack electrofishers, or both will be employed for smaller streams, depending on local geomorphology and in-stream cover. Larger streams will require the same techniques as small streams, but a boat-mounted electrofisher may be needed for deep water. Lakes, which are found only in three network parks (NISI, CARL, and MACA), will be sampled by seine and a boat-mounted electrofisher.

Early fall and late summer are the ideal seasons for sampling lotic systems. Series of specimens representing all size classes will be collected, except in the case of rare species with localized populations, when only the minimum necessary will be collected.

F. Data Analysis

A variety of techniques will be used to analyze, summarize, and report data collected in this inventory. GIS maps will be incorporated into final reports to spatially represent distributions of species within parks. Data also will be analyzed across the combined networks to determine how species are regionally distributed.

Field data sheets will be reviewed for errors after data are collected and will be photocopied and stored at multiple locations until data entry is complete. Data will be entered in the I&M Database Template of Microsoft Access, or a compatible database, and data screening programs may be used to detect potential data entry errors. Copies of all data files will be stored with individual researchers and at a centralized location within the combined networks.

Estimation of Inventory Completeness

Given that parks in these two networks usually are anomalous areas of the southern landscape, it is impossible to accurately predict the number of species in any of these groups. Therefore, throughout the course of the inventory, data analysis will be conducted as an iterative process to determine when 90% of the species in each taxon have been inventoried. The number of species inventoried will be examined as a function of sampling effort, as defined for each taxonomic group. For vascular plants, species richness will be plotted against total area or number of plots sampled. For other groups, such as small mammals, sampling effort may be quantified as the number of trap nights or the number of sampling days. Data will be examined for each taxonomic group following the sampling of grid-point plots to help determine how many stratified sample plots should be selected to reach the 90% inventory goal.

Species richness vs. sampling effort relationships will be examined by strata within each park. Examination by strata will allow researchers to pinpoint which strata need additional sampling and which have received sufficient attention. In addition to plotting species richness against sampling effort, we also will use the Lincoln-Peterson Index (Southwood 1978) as a supporting analysis of inventory completeness. This analysis technique is based on mark-recapture methods (Thompson 1992) and allows the estimation of species richness based upon two species lists generated independently at two different times. Related programs to estimate species richness are available from the USGS Patuxent Wildlife Research Center at http://www.mbr-pwrc.usgs.gov/software.html. These programs were written by J. E. Hines based on methods described by Burnham and Overton (1979).

Many of the parks in the combined networks have had partial inventories completed for vascular plants and vertebrates. Since these inventories usually were not based on a systematic design, assessing their completeness is difficult. To determine completeness, a subset of grid-point and stratified sample plots (5-10 plots per strata) will be inventoried for each taxonomic group. If unlisted species do not comprise more than 10% of all species encountered, then the inventory will be considered 90% complete. If unlisted species comprise greater than 10% of total species, a more extensive inventory will be conducted.

Species Distribution Maps

The proposed study design will allow the collection of systematic information about the distribution of species. Species occurrences for all vertebrates at each park will be mapped based upon presence/absence data. For vascular plants, cover class midpoints (Table 8) will be averaged by species at each plot and used to represent species importance. These values will be used to compare individual species importance among community types and create quantitative distribution maps. GIS can be used to plot maps of predicted species abundance or predicted probability of species occurrence. The predictor variables from regression or discriminant analysis (respectively) then can be used as GIS layers to estimate these probability values at many grid points on the map. Inventory data will be used with site data (slope, aspect, slope position, etc.) and vegetation community classification data to model the distribution of species of special interest (e.g., exotics, threatened species) based upon encounter probabilities. For all special concern species, maps with geo-referenced coordinates for all inventoried populations also will be supplied.

Regional Analysis

In addition to examining species distribution within parks, this study will examine the distribution of individual species across the combined networks. Because many units of the National Park Service serve as relatively small islands of biological diversity that often are under pressure from surrounding land use, it is critical to understand which species may be endemic to one or a few units. This sort of information will not only help protect a species at a given NPS unit, but also will improve management of biological diversity at the regional level. For each species, a list of parks at which it occurs will be compiled.

III. LOGISTICAL SUPPORT AND COMPLIANCE

During site visits to each of the 17 parks, meetings were held with natural resource personnel and usually the superintendents. A series of questions were asked regarding the following topics: recent disturbances, new land acquisitions, special events that researchers may interfere with (e.g., battle re-enactments), restrictions on plot markings, available housing and workspace, safety hazards, space/facilities for storing collections, and other topics. A variety of responses were received, but overall, local park personnel are very enthusiastic about this project and will make every effort to accommodate visiting scientists and provide the needed facilities.

With regard to housing and workspace, some parks have adequate facilities on-site that scientists are welcome to use. Parks that can provide both housing and workspace include ABLI, BISO, CUGA, CHCH, COWP, FODO, GRSM, GUCO, KIMO, MACA, and NISI. Those that can provide workspace only are BLRI, CARL, OBRI, and STRI. A few parks have nothing available (LIRI, RUCA, SHIL), in which case researchers may need to stay in local hotels, campgrounds, bed & breakfasts, etc.

SAFETY is of the utmost concern for scientists visiting these parks. It is assumed that they will be experienced and familiar with field conditions; however, we still felt that this was an important question to ask at each park. Some of the potential safety issues which were brought up during our park visits include the following: venomous insects and snakes, ticks (may carry Lyme disease), hazard trees, abandoned mine shafts, cave openings, difficult terrain, hunting seasons, busy roads, and crime in adjacent communities. Park-specific safety information will be made available to scientists working in those areas.

All investigators must apply for and be approved for a collecting permit in those parks where they will conduct research. These permits will instruct the principal investigator as to the terms that are allowed by the NPS and the specific park for which work is proposed. Federal law requires that actions which could affect natural or cultural resources on federal lands, including research, inventories, and monitoring, be preceded by proper assessment and documentation of potential impacts. The type of inventories discussed in this plan typically do not cause concern regarding the National Historic Preservation Act; however, it is at each park’s discretion to restrict activities if it is felt that a Section 106 compliance issue has arisen. With regard to the National Environmental Policy Act (NEPA), these inventories are categorically excluded except when the Endangered Species Act is an issue. Researchers who anticipate handling endangered species must obtain a permit from the U. S. Fish and Wildlife Service and be familiar with park, state, and federal regulations regarding the handling, disposition, and recovery plans for listed species. Additionally, it is incumbent upon all scientists involved in these inventories to be aware of T&E species that they may encounter.

V. COMPLETION SCHEDULE

The timeline for completion of biological inventories in these two networks (Table 10) is based on anticipated allocation of funds, the existing levels of inventory completion, the level of funding necessary to carry out inventories for specific taxa, and the urgency for some taxonomic groups (e.g., amphibians).

Table 10. Schedule of events per year for plot establishment and conducting inventories for each taxonomic group.

	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05
Plot setup	• planning • air photos • held BRD workshop	• complete air photos for ~13 parks • plot set-up (grid)	• plot set-up (stratified) • specialized habitat selection	• additional stratified plots • habitat type report		
Plants	• evaluated checklists for completeness • gathered literature • held BRD workshop	• begin structured sampling of plots in 8 parks: 7 with partial lists (ABLI, BISO, BLRI, CARL, CHCH, COWP, CUGA), and 1 with no list (GUCO)	• sample stratified plots and specialized habitats	• sample stratified plots • data analysis • final report		
Amphibians	• gathered literature • held BRD workshop	• obligate funds	• begin field work in 6 largest parks (BISO, BLRI, CHCH, CUGA, LIRI, MACA), excluding GRSM	• continue work in original 6 parks • begin sampling in remaining 11 parks	• complete field work in all parks • data analysis • final report	
Reptiles	• gathered literature	• obligate funds	• begin opportunistic collections in each	• begin comprehensive field	• finish field work through summer	

	• held BRD workshop		park by local park staff • record reptile occurrences found in amphibian sampling	sampling	• data analysis • final report	
Birds	• gathered literature • held BRD workshop		• begin breeding bird field work	• continue bird work	• data analysis • final report	
Mammals	• gathered literature • held BRD workshop			• begin mammal work	• data analysis • final report	
Bats	• gathered literature • held BRD workshop			• begin Anabat surveys, supplemented with mist net captures. • winter cave surveys	• complete bat work • data analysis • final report	
Fish	• gathered literature • held BRD workshop			• begin fish sampling	• complete field work • data analysis • final report	
Special concern species		• incidental observations as part of concurrent sampling (in all groups) within standardized design	• incidental observation as part of concurrent sampling (in all groups) within standardized design	• incidental observation as part of concurrent sampling (in all groups) within standardized design	• incidental observation as part of concurrent sampling (in all groups) within standardized design	• full comprehensive specialized surveys on species of high management concern

VI. VOUCHER SPECIMENS

Research permits are required for all collections, even if the specimens are not intended for deposit. Permit request forms and permits are available from each park. The permit process serves as a record that identifies collector(s), purpose of the collection, and clearly states any restrictions. Federally threatened and endangered species (T&E) will not be killed.

Collections will be attempted for all species (except for T&E or if a specimen already exists). High quality voucher photographs will be used for medium and large mammals and birds unless an animal or bird is found dead (e.g., roadkill). Voucher photographs will be clearly labeled with the park name, species name, specific location, date, and photographer. Copies will be made and permanently archived in two places.

If collection is planned, curation must be written into the project (attached to the permit request). Many network parks do not have the space or proper facilities to serve as a repository for voucher specimens; therefore, arrangements will be park-specific depending upon needs and preferences. We plan to have cooperators catalog species information into NPSpecies or a compatible database, which hopefully will allow NPS staff to easily obtain the records and transfer to ANCS+. Collected specimens then will be deposited in park collections or university natural history museums.

VII. PRODUCTS AND DELIVERABLES

Data management will continue with the documentation of existing lists, datasets, GIS layers, and bibliographic records for both networks (the status of data deliverables is presented in Appendix B). A cooperative agreement has been established with Western Kentucky University (WKU) through Spring 2001 to continue data mining and development of NPSpecies and NRBib (as of 1 December 2000, data from 17 parks have been entered into NPSpecies, and bibliographic information has been entered for all 18 parks). Voucher documentation, a process which is just beginning, will also continue as part of this cooperative agreement. This work is being conducted at MACA (30 miles from WKU). Also, the Cumberland/Piedmont Network is establishing two positions in FY01, both at MACA. These positions are: I&M Coordinator and I&M Data Manager. Data management and implementation of the inventory study plan (development of scopes-of-work, cooperative agreements for the inventory field work, etc.) for both networks will be coordinated through these positions. The Appalachian Highlands Network also will hire an I&M Coordinator and Data Manager in FY01 (see Appendices D and E). These positions will be funded out of the Network *Monitoring* budget.

Standardized products will be written into scopes-of-work for all inventory projects, and copies of all products will be delivered to parks in the networks, to the regional I&M Coordinator, and to the servicewide I&M Program Manager. Annual reports summarizing inventory progress will be prepared by the two network I&M Coordinators. Assistance with completion of the databases and GIS layers will be provided by the Network Data Managers where needed, such as with park-level ANCS+ entry, cataloging datasets, and incorporation of GIS layers into the NPS

Theme Manager. The inventory deliverables will include the following:

1. Species data:	NPSpecies format
2. Field data:	I&M Database Template (MSAccess) format (under development) with any necessary modifications to capture special needs
3. GIS layers:	ArcView format, organized into NPS Theme Manager directory structure
4. Metadata:	FGDC format
5. Voucher data:	ANCS+ format and NPSpecies, voucher section format
6. References:	NPBib format linked to NPSpecies
7. Datasets:	Dataset Catalog, NPBib, or whatever is recommended to catalog datasets
8. Annual/Final reports:	MS Word

The networks' two new I&M coordinators will oversee the overall coordination of this project and form a board of directors together with the superintendents of network parks. A technical committee, consisting of park natural resource managers and outside scientists, plus the five members of the study plan development team (i.e., K. Langdon, T. Leibfreid, M. Jenkins, B. Nichols, J. Rock), will serve in an advisory capacity and provide reviews of policies, plans, progress reports, etc. An annual meeting of the board of directors and the technical committee would be advantageous.

When selecting scientists to conduct these inventories, an agreed upon selection priority should be followed. We suggest that potential cooperators include: USGS-BRD scientists, not-for profit organizations, CESU's, major universities, and perhaps NPS staff. Parks may have input on the selection process, particularly if they have a pre-existing working relationship with a local university and would like it to continue, in which case priority would be considered for that institution. For each taxonomic group, a coordinating institution may be established to ensure standardization and quality of deliverables across all parks. We strongly recommend that these inventories be conducted by well qualified scientists and researchers to obtain the highest quality product.